TERRACE
(Feet)
Code 600

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

An earth embankment, a channel, or a combination ridge and channel constructed across the slope.

II. Purpose

This practice may be applied as part of a conservation management system to support one or more of the following:

- Reduce soil erosion.
- Reduce sediment content in runoff water.
- Retain runoff for moisture conservation.
- Improve farmability.

III. Conditions Where Practice Applies

This practice applies where:

- Soil erosion by water is a problem.
- There is a need to conserve water.
- The soils and topography are such that terraces can be constructed and farmed with reasonable effort.
- A suitable outlet can be provided.
- Excess runoff is a problem.

IV. Federal, State, and Local Laws

Users of this standard should be aware of potentially applicable federal, state, and local laws, rules, regulations, or permit requirements governing terraces. This standard does not contain the text of federal, state, or local laws.

V. Criteria

The following criteria apply to all purposes.

A. Spacing

Terrace spacing is measured from the channel of one terrace to the channel of the adjacent terrace (see Figure 3).

Farming width varies with the terrace cross-section: for broad base terraces, the farming width is measured between the tops of ridges of adjacent terraces; for grassed backslope terraces, the farming width is measured from the toe of the backslope on one terrace to the top of the ridge of the next downslope terrace; for narrow base terraces, the farming width is measured from the toe of the backslope of one terrace to the channel of the next downslope terrace.

Horizontal interval is the horizontal slope length or erosion length used to determine terrace spacing (see Figures 1 and 2).

The maximum spacing for terraces for erosion control shall be determined by one of the following methods.

1. $V.I. = xs + y$ or $H.I. = (xs + y)\ (100/s)$

   Where:

   V.I. = vertical interval in feet

   H.I. = horizontal interval in feet (see Figures 1 and 2)

   x = a variable with values from 0.4 to 0.8

   s = land slope in percent

   y = a variable with values from 1.0 to 4.0

   Values of "x" for different geographical zones are shown in Figure 4.

   Values of "y" are influenced by soil erodibility, cropping systems, and crop management practices. A value of 1.0 shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall.

   A value of 4.0 shall be used for erosion-resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre) on the surface. A value

of 2.5 shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 and 4.0 may be used according to the estimated quality of the factors. The horizontal spacing does not have to be less than 90 feet.

2. Revised Universal Soil Loss Equation (RUSLE). The spacing shall not exceed the critical slope length determined by using RUSLE and the allowable soil loss, the most intensive use planned, the expected level of management, and the terrace P factor (Table 1). Soil loss in the inter-terrace interval must be less than or equal to the allowable soil loss.

   In no case shall the maximum horizontal spacing exceed that shown in Table 2 for the conditions shown. The maximum limits may not be exceeded when making the adjustments indicated below.

   Spacing may be increased as much as 10 percent to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet. Spacing may be increased an additional 10 percent for terraces with underground outlets. The spacing shall be adjusted to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing row widths.

   The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be taken into account when determining the terrace interval.

   For level terraces used for erosion control and water conservation, the spacing shall be determined as indicated earlier, but the maximum horizontal spacing shall not exceed 600 feet. An "x" value of 0.8 may be used for all level terraces used primarily to impound water. Figures 1 and 2 show the horizontal interval or erosion length to be used in calculating terrace spacing (Figure 3).

   For terraces on noncropland, the maximum spacing shall be governed by the capacity requirement of this standard.

Table 1

Terrace P Factors

Horizontal Interval (feet)	Closed Outlets[1]	Open Outlets, With Percent Grade of [2]		
		0.1-0.3	0.4-0.7	0.8
Less than 110	0.5	0.6	0.7	1.0
110 - 140	0.6	0.7	0.8	1.0
141 - 180	0.7	0.8	0.9	1.0
181 - 225	0.8	0.8	0.9	1.0
226 - 300	0.9	0.9	1.0	1.0
More than 300	1.0	1.0	1.0	1.0

NOTE: If contouring or stripcropping P factors are appropriate, they can be multiplied by the terrace P factor for the composite P factor.

[1] "P" factors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.

[2] The channel grade is measured on the 300 feet of the terrace or the one-third of total terrace length closest to the outlet, whichever distance is less.

Table 2

Maximum Horizontal Interval for Terraces

Slope Percent	R factor of		With Contour Strip-cropping (feet)	For Concentrated Flow Control (feet)
	0-175 (feet)	More than 175 (feet)		
0 - 2	500	450	600	700
2.1 - 4	400	300	600	700
4.1 - 6	400	200	600	600
6.1 - 9	300	150	400	500
9.1 - 12	250	150	250	500
12.1 - 18	200	150	150	400

Figure 1

Horizontal Interval for Steep Back-Slope Terraces

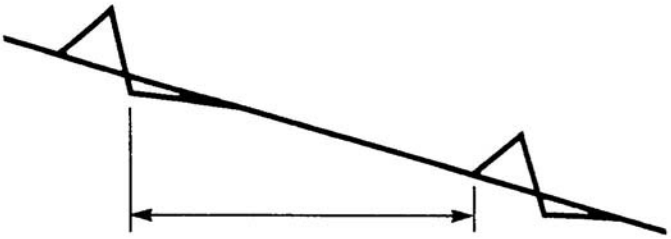


Figure 2

Horizontal Interval for Broad-Based Terraces

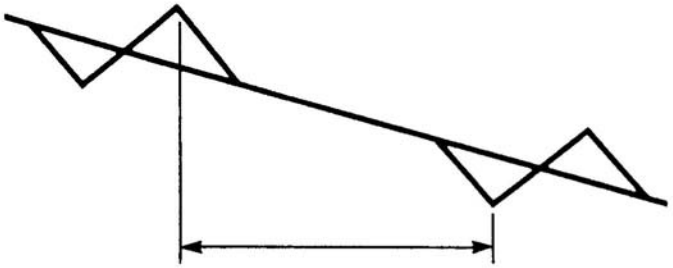
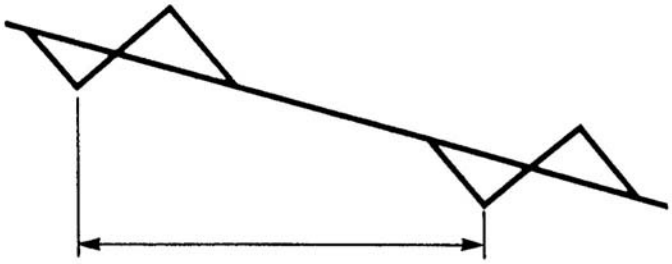


Figure 3

Terrace Spacing



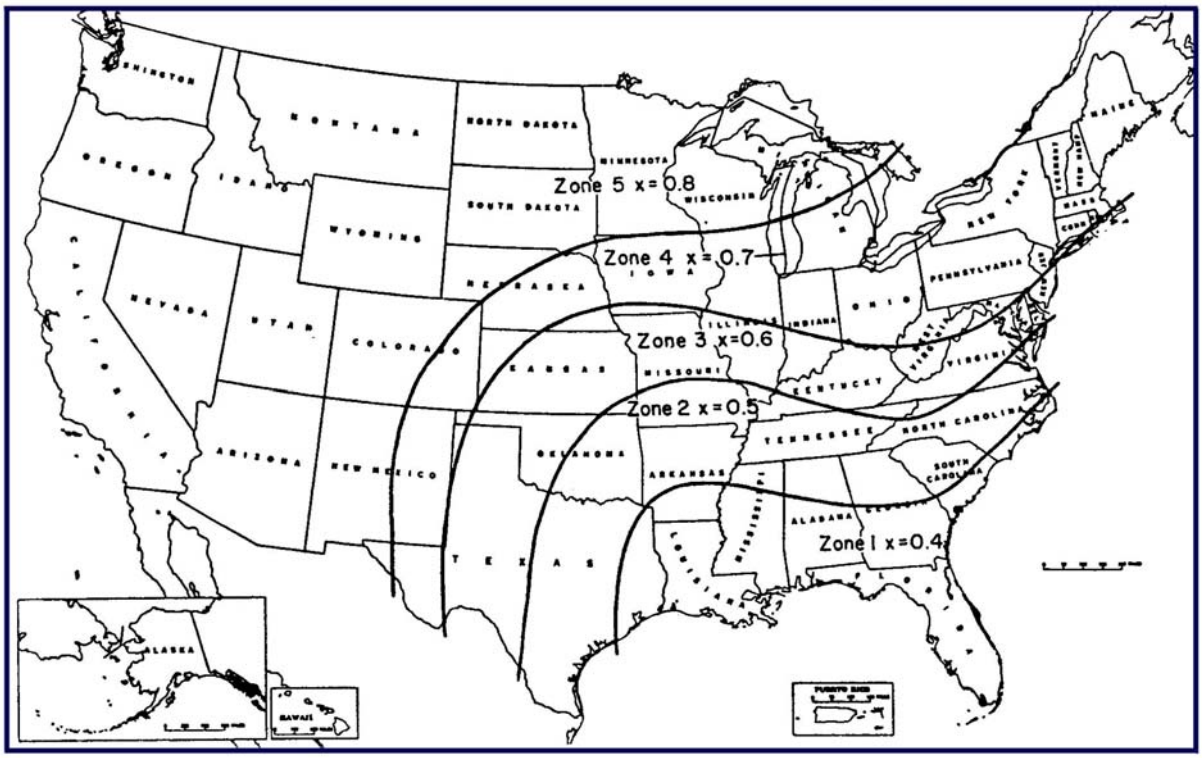


Figure 4 – Values of x in equation V.I. = xs + y or H.I. = (xs + y)(100/s).

B. Alignment

Terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery. Land forming, extra cut or fill along the terrace line, multiple outlets, variations in grade, channel blocks, and other methods shall be used to achieve good alignment. Correction areas will be used where needed to achieve a better contour pattern.

Field efficiency may be used to compare alternative terrace systems. Field efficiency is the ratio of time required to farm the field being planned, to that required to farm a rectangular field of the same acreage 1/2 mile long.

Where wet soil problems do not allow contour farming, planting and harvesting of crops may be performed in a direction other than parallel to the terraces providing all of the following conditions are met:

1. The soils exhibit somewhat poorly drained to poorly drained characteristics where the addition of terraces to the landscape may cause the soil profile to remain saturated for longer periods of time. Examples of these soils are (but not limited to): Hiles, Kert, Marshfield, Milladore, Poskin, Rib, Rietbrock, Sherry, Veedum, Vesper and Withee. Consultation with a soil scientist and the State Conservation Engineer is required when planning terraces on potentially wet soils not listed above.

2. Terraces are installed in accordance with the RUSLE using a practice factor (P) of 1 without exceeding the maximum allowable soil loss.

3. Terraces slopes and channel will be tilled parallel to the channel or be left permanently vegetated.

4. The primary purpose of the terraces is for erosion control.

C. Capacity

The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour duration storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation, unless provisions are made to maintain the design capacity through maintenance. Computer programs approved for use in Wisconsin may be used to design the capacity requirements. Terrace systems designed to provide flood protection or to function with other structures shall have adequate capacity to control a storm of frequency consistent with the potential hazard.

When the capacity is determined by the formula Q = AV (discharge "Q" = area "A" x velocity "V") and the "V" is calculated by using Manning's Formula, an "n" value of 0.06 shall be used for bare channels. Vegetated terrace channels shall be designed using NRCS Technical Paper 61 (TP 61), Handbook of Channel Design for Soil and Water Conservation; Agricultural Research Service Agricultural Handbook 667, Stability Design of Grasslined Open Channels; or NRCS National Engineering Handbook (NEH) Part 650, Engineering Field Handbook (EFH), Chapter 7.

D. Cross Section

The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety.

The ridge shall have a minimum width of 3 feet at the design elevation. The minimum slope of a vegetated front or back ridge slope is 2:1 (2 horizontal to 1 vertical). If necessary, steeper slopes may be used for special purposes but must be stable.

The opening at the outlet end of gradient and open-end level terraces shall have a cross section equal to that specified for the terrace channel.

Figure 5 is a typical cross section for a terrace which can be planted with row crops.

Figure 6 is a typical cross section for a terrace with steep vegetated slopes.

The minimum design depth for any terrace is 1.0 foot. A minimum allowance of 10 percent of the fill height shall be provided for settlement.

Gradient terrace channel flow depths shall be increased to allow for sediment deposition. Increase the flow depth at least 5 percent when the annual soil loss is expected to be lower than 2 tons/acre, and 10 percent or more when the annual soil loss will exceed 2 tons/acre.

The channel cross section may be V-shaped or trapezoidal.

MINIMUM TERRACE CROSS SECTION (BROAD BASE FARMABLE TERRACE)

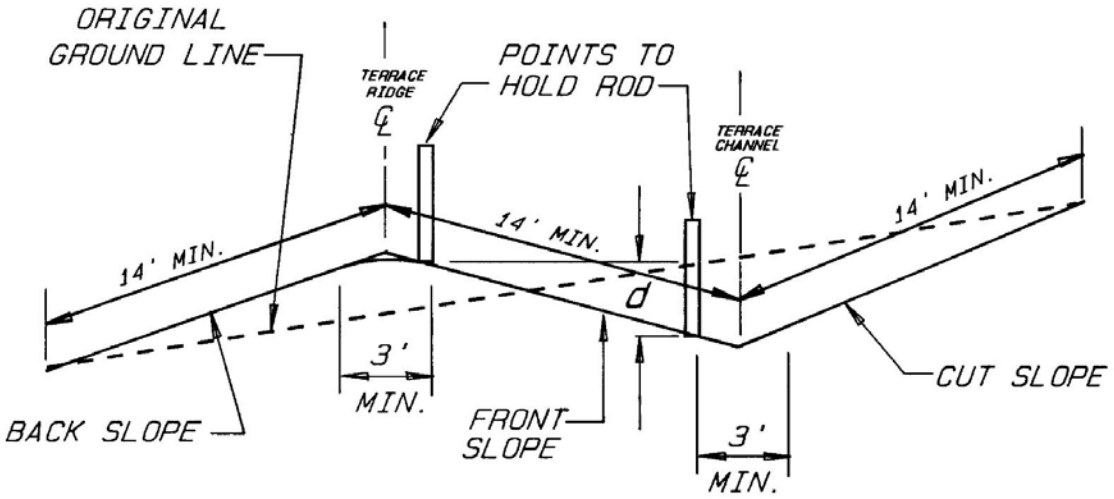
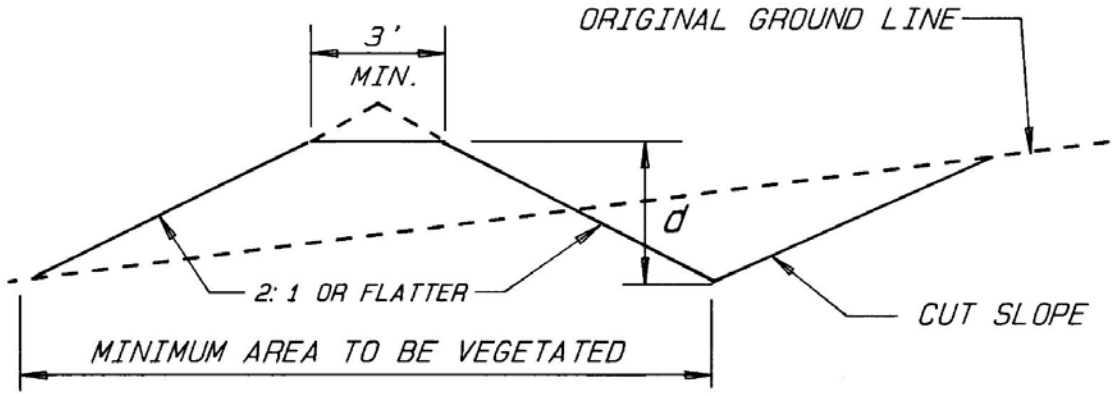


FIGURE 5

d=REQUIRED DEPTH INCLUDING ALLOWANCE FOR SETTLEMENT AND SEDIMENT

MINIMUM TERRACE CROSS SECTION (VEGETATED RIDGE TERRACE)



d=REQUIRED DEPTH INCLUDING ALLOWANCE FOR SETTLEMENT AND SEDIMENT

FIGURE 6

E. End Closures

Level terraces may have open ends, partial end closures, or complete end closures. Partial and complete end closures shall be used only on soils and slopes where the stored water will be absorbed by the soil without appreciable crop damage or where underground outlets are provided.

If terraces with closed or partly closed ends are specified, the end closures must be installed before the terraces are completed. The end closures shall be designed so that the water flows over the end closure before overtopping the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace ridge. Complete end closures are more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

F. Channel Grade

Channel grade shall be determined by one of the following methods:

1. Maximum channel grade in the lower reaches of the channel shall not exceed 0.6 percent.

2. Maximum channel velocity for farmed channels shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 feet/second; for average soils, 2.0 feet/second; and for easily erodible soils, 1.5 feet/second. Table 3 shall be used as a guide to the erosion resistance of soil. Velocity shall be computed by Manning's Formula, using a "n" value of 0.035 or less.

3. Maximum channel velocities for permanently vegetated channels shall not exceed those used for Standard 412, Grassed Waterway, in the NRCS Field Office Technical Guide (FOTG), Section IV.

Channel grades may be uniform or variable. Channel velocity shall not exceed that which is nonerosive for the soil and planned treatment.

For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment.

If terraces have an underground outlet, water and sediment will pond in the channel, thus reducing the velocity and allowing steeper channel grades near the outlet.

Minimum grades shall be such that ponding in the channel because of minor irregularities will not cause serious damage to crops or delay field operations.

Table 3

Permissible Velocities for Non-Vegetated Terrace Channels

Soil Texture[1]	Permissible Velocity (feet/second)
Sands, Silts, and Loams (SW, SP, ML, SM, SM-SC, CL-ML)	1.5 Easily Erodible
Silty Clay Loams, and Sandy Clay Loams (SC, CL) PI<10	2.0 Average
Silts, Clay (MH, CL, CH) PI≥10	2.5 Erosion Resistant

[1] General description and United Soil Classification System designation. PI is plasticity index.

G. Terrace Length

The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break is minimized. Level terrace length shall not exceed 3,500 feet unless the channel is blocked at intervals not exceeding 3,500 feet. Normally, the gradient terrace length is controlled by the capacity and the nonerosive velocity requirement.

H. Outlets

All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or a vegetated area. The outlet must convey runoff water to a point where the outlet flow will not cause damage. Outlets shall be installed and adequately vegetated before the

terrace is constructed to provide a stable nonerodible outlet. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on gradient or level terraces. The outlet consists of an intake and an underground conduit. An orifice plate, increase in conduit size or other features shall be installed as needed to control the release rate and prevent excessive pressure when more than one terrace discharges into the same conduit. The discharge, when combined with the storage, shall be such that a 10-year frequency, 24-hour duration storm will not overtop the terrace, and growing crops will not be damaged significantly by standing water. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops, depending on soil characteristics and water tolerance of crops to be grown.

The underground conduit shall meet the requirements specified for NRCS FOTG Standards 620, Underground Outlet, and 606, Subsurface Drain. Conduits must be installed deep enough to prevent damage from tillage equipment.

The inlet shall consist of a vertical perforated pipe of a material suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment and subsequent raising of the terrace ridge.

Blind inlets may be used where they are effective, usually in well-drained soils.

The outlet of the conduit shall have adequate capacity for the design flow without causing erosion.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit drainage of the design storm from the terrace channel within a reasonable period so crops are not significantly damaged by standing water.

Combinations of different types of outlets may be used on the same system to maximize water conservation and to provide for economical installation of a more farmable system.

Underground conduits shall be plastic or PVC tubing, or other pipe capable of supporting the necessary loadings. All perforated tubing or pipe shall be installed on grades which will not exceed the velocities allowed for the various soil textures contained in NRCS FOTG Standard 606, Subsurface Drain.

Whenever terraces with underground outlets are constructed concurrently or within the same calendar year, the trench slopes beneath the terrace ridge shall be sloped to 1/2:1, or flatter, before backfilling and compaction.

I. Vegetation

All areas to be vegetated shall be established to grass as soon as practicable after construction.

Terraces to be seeded or with slopes not intended to be cropped shall be seeded in accordance with NRCS FOTG Standard 342, Critical Area Planting.

J. Safety

Terrace ridges, especially those with steep back slopes, can be very hazardous. For this reason, some farmers prefer steep front slopes, thus keeping machinery away from the steep back slopes. All cut and fill slopes that are to be farmed must be no steeper than those on which farm equipment can operate safely.

VI. Considerations

Additional recommendations relating to design that may enhance the use of, or avoid problems with, this practice but are not required to ensure its basic conservation functions are as follows.

A. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.

B. Effects of nutrients and pesticides on ground water quality.

C. Short-term and construction-related effects on the quality of downstream water.

D. Effects on wetlands or water-related wildlife habitats.

VII. Plans and Specifications

Plans and specifications for installing terraces shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

VIII. Operation and Maintenance

An Operation and Maintenance Plan shall be developed that is consistent with the purpose of this practice, intended life of the components, and criteria for design.

The minimum requirements to be addressed in the operation and maintenance plan area:

A. Provide periodic inspections, especially immediately following storms with a 10-year or greater return frequency.

B. Promptly repair or replace damaged components as necessary.

C. Maintain terrace capacity, ridge height, and outlet elevations.

D. Remove sediment that has built up in the terrace to maintain a positive channel grade.

E. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.

F. Vegetation shall be maintained and trees and brush controlled by chemical or mechanical means.

G. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

IX. References

USDA, NRCS, Wisconsin Field Office Technical Guide, Section IV, Conservation Practice Standards and Specifications.

USDA, NRCS Technical Paper 61, Handbook of Channel Design for Soil and Water Conservation.

USDA, Agricultural Research Service, Agricultural Handbook 667, Stability Design of Grasslined Open Channels.

NRCS National Engineering Handbook Part 650, Engineering Field Handbook, Chapter 7.